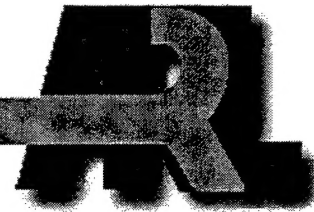


ARMY RESEARCH LABORATORY



# Human Factors Military Lexicon: Auditory Displays

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# **Army Research Laboratory**

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## **Human Factors Military Lexicon: Auditory Displays**

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## Abstract

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This report is a lexicon of terms developed by the Department of Defense Spatial Audio Display Working Group in an attempt to standardize terminology used by human factors researchers working in the area of auditory displays and human-machine communication. The lexicon has been primarily developed for the U.S. armed forces research groups, but it is hoped that it will be also useful for other Government, academic, and industrial organizations. In addition to definitions specific to auditory displays, speech communication, and audio technology, the lexicon includes several terms unique to military operational environments and human factors engineering applications. Furthermore, human factors researchers appear to be increasingly interested in conducting integrated studies of auditory and visual perception in order to answer broad questions related to human situational awareness and performance. Therefore, the lexicon also includes some definitions related to visual perception, particularly in the areas of visual displays, virtual reality, and communication symbology.

## ACKNOWLEDGMENTS

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# HUMAN FACTORS MILITARY LEXICON: AUDITORY DISPLAYS

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## 1. Introduction

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The field of auditory displays and spatial hearing has virtually exploded in the past 10 years. This rapid expansion has involved scientists and engineers working in acoustics, electronics, human factors, psychology, the arts, and military research. A natural consequence of this multi-disciplinary interest in auditory displays is that many different terms are now used in the literature to describe the same procedures or phenomena. Some terms have different meanings for people working in different fields of science. Therefore, it seems appropriate to develop a unified set of terms, definitions, and abbreviations to be used by researchers, engineers, and managers working in the area of auditory displays.

In an effort to create a complementary research program in the area of auditory displays, scientists from the Air Force, Army, Navy, and National Aeronautics and Space Administration research laboratories formed the Department of Defense Human Factors Engineering Spatial Audio Display working group. The group first met at Wright-Patterson Air Force Base, Ohio, from December 5 through December 7, 1995. The group developed some basic guidelines for cooperation and data exchange and has become a platform for developing joint research programs. It has also required its members to standardize terminology used by human factors researchers working in the area of audio displays. During a meeting on January 26 and 27, 1999, the group tasked Tomasz Letowski of the Human Research and Engineering Directorate, U.S. Army Research Laboratory, to coordinate efforts in developing a formal lexicon of terms related to the broad area of auditory displays and their human factors applications.

The current document is the result of efforts of many people in developing a unified terminology and provides a basic reference for spatial hearing and auditory display terminology. In addition to definitions specific to auditory displays, this lexicon includes several terms unique to military operational environments and human factors applications. Human factors researchers appear to be increasingly interested in conducting integrated studies of auditory and visual perception in order to answer broad questions related to human sensory perception and performance. Therefore, we have included in this lexicon some definitions related to visual perception, particularly in the areas of displays and communication symbology. It is hoped that this lexicon will be useful for those inside and outside the U.S. armed forces, who are working and interested in the fields of spatial hearing and auditory displays. However, this is the first effort to create such a lexicon, so obviously, some terms and definitions will not satisfy everybody, some terms are missing, and some are superficial.

Therefore, the authors will be very indebted to the readers of this lexicon for critical comments and suggestions regarding ways to improve the lexicon in the future. Please send your comments to

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## 2. Terms and Definitions

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**Absolute Threshold:** The minimum stimulus that evokes a desired response in a specified fraction of the trials (American National Standards Institute [ANSI], 1995). The minimum amount of energy required by a person to detect the presence of a stimulus.

**Acclimatization:** The physiological adaptation of a listener to new listening conditions.

**Acoustic:** Pertaining to sound.

**Acoustic Alarm:** An acoustic signal emitted by a system to indicate that a dangerous condition of the system has been reached.

**Acoustic Display:** [see Auditory Display]

**Acoustic Environment:** The aggregate of all sound fields that characterize a specific space or location.

**Acoustic Event:** A sound having a specific beginning and end.

**Acoustic Field:** A description of the behavior of sound in a specific space. The distribution of acoustic pressure generated by one or more sound sources in the specific open, partially bound, or fully enclosed space. An area in space containing sound waves (ANSI, 1994 - modified).

**Acoustic Icon:** A sound having a specific meaning.

**Acoustic Shadow:** A region in which a sound field is reduced in its magnitude due to the presence of an obstacle or the presence of interference (ANSI, 1973).

**Acoustic Signal:** An acoustic wave carrying information [see Signal].

**Acoustic Space:** A sum of acoustic conditions characterizing a given space.

**Acoustic Wave:** A mechanical disturbance propagating through an elastic medium.

**Acoustics:** The science or study of the production, transmission, and reception of acoustic waves.

**Active Noise Reduction:** The process of reducing background noise by electronically inverting its phase by 180 degrees and adding this inverted signal to the original noise.

**Adaptation:** A property of sensory receptors whereby sensory response to continuous or repeated stimuli decreases. Auditory adaptation may occur during or following acoustic stimulation too weak to produce [see] **auditory fatigue**. Adaptation effects on the threshold of audibility are much milder and of shorter duration than those caused by auditory fatigue.

**ADAT® (Alesis Digital Audio Tape):** A digital tape recording system developed by Alesis, putting eight tracks of 16-bit, 44.1-kHz digital audio on vertical helix scan tape (Rane, 1999).

**ADSR (Attack-Decay-Sustain-Release):** The four time constants associated with signals generated by music synthesizers, which define the envelope of the generated signal. Attack time is the time needed for the signal to reach its maximum value. Decay time is the time required for the signal to decrease to the sustain level. Sustain time is the time during which the magnitude of the signal remains constant. Release time is the time needed for the signal to decrease to zero level.

**Advisory Signal:** A signal to indicate a safe or normal configuration, condition of performance, operation of essential equipment, or to attract attention and impart information for routine action purposes, including a signal to indicate a change in system status, which, while important, does not require immediate action on the part of the operator (Department of Defense, 1999).

**AES/EBU Digital Audio Bus:** A digital sound transmission standard accepted by the Audio Engineering Society (AES) and the European Broadcasting Union (EBU) for stereo digital audio and associated data (sub-channel data). The official name for the standard is AES3-1985 (ANSI, 1985).

**Air Conduction:** The process by which sound is conducted to the internal ear through the air in the ear canal (acoustic *meatus*).

**Algorithm:** A set of instructions and operations describing how to transform one or more input variables into one or more output variables in a finite number of steps.

**Aliasing:** Creation of unwanted signal components during signal [see] **sampling**, when the signal frequency is higher than half of the [see] **sampling frequency**.

**All-pass filter:** A filter that provides only phase shift or phase delay, without appreciably changing the magnitude characteristic (Rane, 1999).

**Ambience:** A perceived character of the acoustic environment (space) surrounding the listener. The extent to which sound appears to surround the listener.

**Ambient Noise:** All-encompassing sound at a given location, usually a composite of sounds from many sources near and far (ANSI, 1994).

**Ambisonics:** A four-channel [see] **surround sound** standard developed by Michael Gerzon (1945-1996). Ambisonics uses four input channels, two transmission channels, and four or more reproduction channels.

**Analog Signal:** A continuously varying signal representing a continuously varying activity.

**Analog Signal Processing:** Techniques for processing signals while they are being represented as continuous values, typically voltages [see **Analog Signal**]. Some common analog signal-processing operations are filtering, limiting, amplitude compression, and amplification.

**Analog-to-Digital Conversion (ADC):** The process of changing an analog signal into a digital form.

**Analytic Listening:** The ability of a listener to perceptually isolate individual elements of a complex sound (McAdams & Bigand, 1993) [see **Synthetic Listening**].

**Anechoic Chamber:** A room whose boundaries absorb practically all the incident acoustic waves and provide effectively free-field conditions in the frequency range of interest (ANSI, 1973).

**Anti-aliasing Filter:** A low pass filter used at the input of an ADC to eliminate signal components that are higher in frequency than one-half of the [see] **Nyquist frequency**.

**Anti-imaging Filter:** A low pass filter used at the output of a digital-to-analog converter to eliminate aliasing produced by the converter and to reconstruct a smooth analog signal.

**Anthropometric Dimensions:** Measured dimensions that describe the size and shape of the human body. These dimensions are often presented in the form of

summary statistics that describe the range of body dimensions that are observed in a stated population (Department of Defense, 1999).

**Anthropometry:** The scientific measurement and collection of data about human physical characteristics and the application (engineering anthropometry) of these data to the design and evaluation of systems, equipment, and facilities (Department of Defense, 1999).

**Aural Exiter™:** A trade name for a device developed by Aphex Systems, which adds "even-order" harmonic distortion to a signal for the purpose of making it more audible in the presence of other signals (White, 1987). Added harmonics make the signal a little bit brighter and crisper with minimal change in loudness.

**Apogee:** A point along a sound source trajectory that is the highest or most distant from the listener.

**Apparent:** Not actually being what appearance indicates (Webster, 1999). Manifesting to the senses or mind as real or true on the basis of evidence that may not be factually valid [see **Phantom**].

**Artificial Intelligence:** The capability of a device to perform functions, such as reasoning and optimization through experience, that are normally associated with human [see] **intelligence**.

**Attention:** A condition of readiness for applying the mind to an object of sense or thought through a selective narrowing or focusing of consciousness and receptivity (Webster, 1999 – modified).

**Audibility Threshold:** The minimum (a) sound pressure level or (b) force level of a signal that is capable of evoking an auditory sensation in a specified fraction of the trials (ANSI, 1995 - modified]. The audibility threshold is defined for a given listener and a specified signal.

**Audification:** A direct playback of non-acoustic data as sound (Kramer, 1994, p. xxvii). Non-acoustic data can be a data matrix, a digitized picture, or the temperature sensor output.

**Audio:** Pertaining to an acoustic signal encoded in electrical form and to the means of its transmission.

**Audio Bandwidth:** The range of audio frequencies that an electronic system is able to reproduce within predetermined tolerances.

**Audio Display:** An [see] **auditory display** generated by audio signals.

**Audio Frequency:** An acoustic frequency at which a sound is normally audible.

**Audio Frequency Range:** Frequency range that extends from the lowest to the highest acoustic frequencies perceived by humans, typically from 20 Hz to 20,000 Hz.

**Audio Icon:** An acoustic icon generated by an audio signal.

**Audio Signal:** An audible acoustic signal recorded or generated in an electrical form and reproduced by loudspeakers or earphones.

**Audition:** The act of listening. Sense of hearing (ANSI, 1995)].

**Auditory:** Pertaining to hearing or audition.

**Auditory Agnosia:** Inability to recognize auditory objects, events, and sequences.

**Auditory Alarm:** An acoustic signal emitted to alert people about the presence of danger. An acoustic signal used to alert the operator that a dangerous condition of the system has been reached.

**Auditory Awareness:** The ability to hear incoming sounds, understand their meaning, and to locate their origin in space. Access to and understanding of [see] **acoustic environment**.

**Auditory Critical Band:** The frequency band within which the loudness of a continuously distributed sound of constant sound pressure level is independent of its bandwidth. Also, frequency band of a continuous-spectrum noise that contains a sound pressure level equal to that of a just audible pure tone located in the center of the band (ANSI, 1995).

**Auditory Display:** A display presenting information capable of being heard.

**Auditory Distance Estimation:** The psychological process by which a listener determines the distance to the sound source.

**Auditory Event:** An auditory sensation having a specific beginning and end.

**Auditory Fatigue:** Temporary decrease in hearing sensitivity caused by previous auditory stimulation. Auditory fatigue produces a temporary threshold shift that may last seconds, minutes, hours, or days (ANSI, 1995) [see **Adaptation**].

**Auditory Fusion:** The sensation of a single continuous sound caused by a series of sounds of short duration with successive arrival times.

**Auditory Group:** Sounds that arrive simultaneously or sequentially and contribute to a specific auditory image. An auditory stream is a form of an auditory group.

**Auditory Grouping:** The perceptual process by which a listener organizes information obtained from an acoustic signal into individual meaningful entities [see **Auditory Group**].

**Auditory Icon:** An icon intended to be heard.

**Auditory Image:** An overall auditory sensation created by a specific acoustic signal during specific listening conditions. An auditory representation of a specific auditory stimulus. An auditory image consists of two main elements: [see] **sound character** and **spaciousness**.

**Auditory Meatus:** The ear canal.

**Auditory Orientation:** An awareness of surrounding physical space, which is obtained through audition.

**Auditory Perception:** A mental analysis of auditory sensations based on prior experience and world knowledge to determine meaning of the stimulation [see **Perception**].

**Auditory Sensation:** The primary experience of sound received by a listener. Auditory sensations can be created by external stimulation or can be auditory illusions created by the human brain [see **Sensation**].

**Auditory Signal:** An acoustic signal received or intended to be received by the ear.

**Auditory Skill Development:** Repetition of auditory tasks designed to develop or improve skills necessary to interpret auditory sensations as meaningful events.

**Auditory Stream:** A sequence of sounds treated by the auditory system as coming from a single source.



**Auditory Streaming:** A mental process of separating incoming sounds into [see] **auditory streams**.

**Auditory Symbology:** The study or interpretation of [see] **auditory icons**.

**Auditory System:** Sensory system of the living organism dedicated to the reception of acoustic signals.

**Auditory Training:** [see **Auditory Skill Development**]

**Auditory Workload:** The amount of work assigned to or expected from the sense of hearing in a specified time period.

**Auralization:** Creation of virtual acoustic environments by rendering specific sound events on the impulse response characterizing a real or non-existent space.

**Aural Image:** [see **Auditory Image**].

**Aural Non-Detectability Distance:** The distance at which, for given conditions, the one-third octave band pressure levels of a noise source at a listener's location are below both the sound level of a quiet environment and average hearing in all one-third octave bands (Department of Defense, 1997).

**Aureal™ 3D:** Proprietary [see] **spatial sound display** technology developed by Aureal (formerly Crystal River Engineering).

**Auricle:** The external part of the human ear that is attached to the head around the opening of the external auditory *meatus*; the most visible part of the ear. The auricle is believed to be useful in the localization of sounds in the front-back and the vertical directions.

**Automatic Loudness Compensation:** Compensation circuitry in audio systems intended to overcome reduced sensitivity of the human hearing to low and high frequencies at low sound pressure levels.

**Average Hearing:** The binaural free-field hearing threshold for steady state sounds for normal ears defined in International Standards Organization Recommendation R-226 (Department of Defense, 1997).

**Awareness:** Alertness in drawing inferences from what one experiences (Webster, 1999).

**Background Noise:** [see **Ambient Noise**].

**Baffle:** A structure that impedes the flow of sound into a certain area.

**Bass:** The lower region of the audio frequency range, to about 500 Hz.

**Binaural:** Pertaining to, using, or involving the functions of two ears.

**Binaural Advantage:** Improvement in the reception of an auditory signal because of the interaction of two ears.

**Binaural Audio:** A method for recreating an original sound field by reproducing a [see] **binaural recording** of the original sound field through earphones.

**Binaural Dummy Head:** A replica of the human head (or the human head and torso) with microphones placed in the ear canals, at the eardrum position, for making acoustic measurements and sound recordings [see **HATS, KEMAR**].

**Binaural Fusion:** Sensation of a single sound caused by two different sounds delivered to the left and right ears.

**Binaural Listening:** Listening with two ears.

**Binaural Recording:** A recording made or a process of making the recording with a [see] **binaural dummy head**.

**Binaural Release from Masking:** Improvement in the detection of a signal in a binaural listening condition, when signal and masker are out of phase between ears in comparison to when they are in phase between ears, even though the amount of power in the masking signal is equal in both conditions.

**Binaural Signal:** A two-channel audio signal recorded with a [see] **binaural dummy head**.

**Bionics:** The science of applying information about the functioning of biological systems to the solution of engineering problems. A study of the use of technology to match or even improve the abilities of the human body.

**Biotic Display:** An [see] **earphone display** presenting [see] **stereophonic signals** to the ears of the listener.

**Biotic Mode:** A sound delivery mode in which a [see] **stereophonic signal** is delivered to the ears of the listener.

**Blocked Meatus Measurement Technique:** A method of measuring [see] HRTFs in which a microphone is placed at the opening of the ear canal and is blocked with an earplug.

**Bone Conduction:** The process by which sound is conducted to the internal ear through the cranial bones.

**Brickwall Filter:** A low-pass filter with a steep cut-off slope. Brickwall filters are used as [see] anti-aliasing filters and anti-imaging filters.

**Bucking:** The cancellation of one signal by another signal with equal amplitude but opposite polarity (White, 1987).

**Bus:** A collection of wires through which signals and conditions are transmitted from one part of a system to another.

**Categorization:** A process of assigning organisms, objects, events, or data to specific groups or classes (categories) according to established criteria.

**Category:** A specific distinct class embracing similar objects or concept.

**CAVE (Cave Automatic Visual Environment):** CAVE is an example of a [see] virtual reality interface developed at the Electronic Visualization Laboratory, University of Illinois. CAVE is a virtual reality room (a 3-meter cube) whose floor and three walls serve as projection surfaces for stereographically (via shutter glasses) projected computer visualization.

**Channel:** A path or a specified frequency band along which signals, information, or data flow (Isaacs, 1996).

**Circumaural Earphone:** An earphone that presses against the head with little or no contact with the surface of the pinna; the transducer is loosely coupled to the ear by the relatively large volume of air under the ear cup or earmuff (ANSI, 1995).

**Clifton Effect:** The phenomenon experienced by the listener attending to repeated presentations of two "clicks," one from a loudspeaker on the left followed shortly by a second click from a loudspeaker on the right, causing the second click to fade from awareness after some time and contribute solely to a general sense of spaciousness. The Clifton Effect needs 10 or 20 clicks over a period of a second or so to become established. After the effect is established and the right and left signals are switched, the listener once again hears the two clicks until the effect eventually dominates again. The Clifton Effect

demonstrates that the mechanism for echo suppression is dynamic and fairly subtle, taking time to become established.

**Cockpit Trouble:** Problems with the recording or reproduction of sound caused by an inept user (White, 1987). Also "a short between the earphones."

**Cocktail Party Effect:** The phenomenon that permits a listener to attend to a single talker in a complex acoustic environment when competing talkers are spatially separated. The Cocktail Party Effect allows a person to attend to a single conversation against a background of multiple competing conversations.

**Cognition:** (1) Every process by which a living creature obtains knowledge of some object or becomes aware of its environment [Eysenck, Arnold, & Meili, 1972]; (2) A process of acquiring knowledge; (3) The act or process of knowing, including both awareness and judgment (Webster, 1999).

**Cognitive Engineering:** A study of implications associated with the interaction of people and computers. Cognitive engineering focuses on key design problems in communication, information storage and retrieval, and training related to the use of computers.

**Cognitive Fightability:** The capability of effective mental performance in a combat environment [see **Fightability**].

**Coincident-Microphone Recording:** A stereophonic recording made with the [see] **X-Y microphone technique**.

**Coloration:** The unintended spectral modification of sound during a transmission process.

**Comb Filter:** A filter that has a series of very deep notches that are multiples of the lowest frequency notch. A comb filter effect is produced by [see] **flanging**.

**Communication:** A process by which information is exchanged between individuals through a common system of symbols, signs, or behaviors (Webster, 1999).

**Complex Sound:** A sound that consists of more than one sine wave.

**Cone of Confusion:** Points around a listener's head that produce the same interaural time and intensity differences at the ear and therefore provide the same directional cues. The effect of a cone of confusion is usually resolved with head movements.

**Consciousness:** The quality or state of being aware, especially of something within oneself (Webster, 1999).

**Crew Station:** A complete physical environment in which a group of people performs their tasks and missions.

**Critical Display:** A display required for mission success (Department of Defense, 1999).

**Critical Distance:** A distance from the sound source in a given direction at which the direct sound energy and the reflected sound energy are equal.

**Critical Task:** A task requiring human performance which, if not accomplished in accordance with system requirements, will most likely have adverse effects on cost, system reliability, efficiency, effectiveness, or safety (Department of Defense, 1999).

**Critical Warning:** A warning that indicates a condition which, if not corrected, will result in mission failure, equipment damage, or personal injury [see **Warning Signal**] (Department of Defense, 1999).

**Cybernetics:** The science of control and communication in living organisms, machines, and organizations. A study of mechanisms that regulate themselves. The term was originally used by Plato in his *Dialogues* and later in 1840s by Polish philosopher Bronislaw Trentowski (*The relation of philosophy to cybernetics, or the art of how to govern to nation*, Poznan, 1843) and French physicist André-Marie Ampère (*cybernetique*). The word became popular after Norbert Wiener's book *Cybernetics* was published in 1948.

**DAT (Digital Audio Tape):** A digital magnetic tape format for audio recording. DAT recorders use a magnetic tape cassette system with either stationary heads (S-DAT, two-channel) or rotary heads (R-DAT, four-channel) similar to those of a video recorder.

**Delta Modulation:** A one-bit coding technique, in which the signal is encoded as the difference between successive levels, rather than as the absolute value of each sample.

**Delta-Sigma Modulation:** An ADC scheme based on [see] **delta modulation**, which provides one-bit information at a very high rate in a format that a digital filter can directly process. The term was coined by Inose and Yasuda in 1962. Because of a misunderstanding, the words were interchanged and this scheme is commonly called *sigma-delta modulation*.

**Detection:** The determination of the presence of stimulation. The ability to state that a signal is present.

**Detection Range:** A distance within which a given sound source can be detected. Depending on whether the point of reference is the source of sound or the listener, one can talk about a source-related detection range or a listener-related detection range, respectively.

**Detection Threshold:** The smallest value of a specific stimulus noticeable by the observer. The smallest value of a signal registered by a sensing device [see **Sensitivity**].

**Dichotic Display:** An [see] **earphone display** presenting uncorrelated acoustic signals to the left and right ears of the listener.

**Dichotic Mode:** A sound delivery mode in which independent auditory stimuli are delivered to the left and right ears of the listener.

**Difference Limen:** The minimum change in a stimulus that can be correctly judged as different from a reference stimulus in a specified fraction of trials (ANSI, 1995).

**Differential Threshold:** [see **Difference Limen**]

**Diffuse Sound Field:** A specific type of [see] **reverberant sound field** in which the sound intensity is uniform across the field and the flow of acoustic energy in all directions is equally probable.

**Digital Audio:** The use of sampling and quantization techniques to store or transmit audio information in binary format. The use of numbers (typically binary) to represent an audio signal (Rane, 1999).

**Digital Signal:** Any signal that is quantized (i.e., limited to a distinct set of values) into digital words at discrete points of time. The accuracy of a digital value is dependent on the number of bits used to represent it (Rane, 1999).

**Digital Signal Processing (DSP):** Signal processing of a digitized signal. Techniques for modifying and analyzing a signal after it has been sampled and converted into digital form by an ADC. DSP is becoming increasingly popular because of the flexibility in signal processing that it provides and the rapidly decreasing prices of microprocessors that are fast enough to implement the DSP algorithms in real time.

**Digital Signal Processor (dSP):** A microprocessor optimized to implement DSP algorithms such as digital filters. A dSP often contains on-chip memory and can provide an order of magnitude of higher performance than general purpose microprocessors of comparable price.

**Digital-to-Analog Conversion (DAC):** The process of changing a digital signal into an analog form.

**Diotic Display:** An [see] **earphone display** presenting the same acoustic signal (e.g., monophonic signal) to both ears of the listener.

**Diotic Mode:** A sound delivery mode in which the same auditory stimulus (e.g., monophonic signal) is delivered to both ears of the listener.

**Direct Sound Field:** A sound field in which sound energy radiated by a source dominates over energy reflected by spatial boundaries [see **Reverberant Sound Field**].

**Directivity Pattern:** A plot of the sensitivity of a sound receiver as a function of the direction toward the sound source or a plot of the effectiveness of a sound source as a function of the direction toward the sound receiver.

**Discrimination:** The process or ability to differentiate one stimulus (signal) from another.

**Discrimination Threshold:** [see **Difference Limen**].

**Display:** A unique device or assemblage of devices used to systematically present specific information capable of being perceived by the human senses. A systematic presentation of information to the senses.

**Display Format:** The organization of different types or elements of data in a display (Department of Defense, 1999).

**Display Tailoring:** Designing displays to meet the specific needs of the user, rather than providing a *general* display that can be used for many purposes (Department of Defense, 1999).

**Display Update:** The regeneration of changed data to show current status, by user request or automatically by the computer (Department of Defense, 1999).

**Divided Attention:** The human ability to keep track of two or more independent activities happening simultaneously in the environment [see **Selective Attention**].

**Dolby AC-3™.** A six-channel digital audio data compression (coding) algorithm used in the 5.1 [see] **surround sound** applications developed by Dolby Laboratories.

**Dolby Pro-Logic™:** A five-channel [see] **surround sound** standard developed by Dolby Laboratories.

**Dolby Headphone Technology™:** A proprietary technology developed by Lake Technology that creates a [see] **surround sound** experience over stereophonic headphones playing any multichannel audio signal.

**Earcon:** An abstract synthetic sound used to convey a specific meaning, e.g., an auditory alarm. A type of acoustic icon.

**Earphone:** An electroacoustic transducer directly coupled to the ear of the listener.

**Earphone Display:** An [see] **auditory display** using earphones.

**Echoic Memory:** A hypothetical sensory register within which auditory information is temporarily stored without being recoded (McAdams & Bigand, 1998).

**Ecology:** The branch of the biological sciences that concerns the relationship between organisms and their environment, including their relationship with other organisms (Morris, 1992). The study of living organisms as they exist in their natural surroundings or habitats.

**Egocentric Judgment:** In auditory distance perception, a location in space perceived in absolute terms, i.e., as a distance in meters from the listener.

**Electroacoustic:** [see **Audio**].

**Electroacoustic Transducer:** A transducer designed to receive an electrical signal and convert it into an acoustic signal or vice versa.

**Electronic Sound:** A sound generated by electrical or electronic means.

**Engineering:** The application of scientific knowledge about matter and energy for practical human uses [also see **Human Engineering**] (Morris, 1992).



**Engineering Psychology:** An area of psychology that studies the relationship between human behavior and machines, especially for the purpose of designing tools and machinery (Morris, 1992).

**Environment:** The aggregate of all the conditions and influences including physical location and operational characteristics of surrounding equipment and structures (Department of Defense, 1999).

**Environmental Engineering:** Any technological activity that works to reduce or prevent the pollution or degradation of areas in which humans live (Morris, 1992).

**Environmental Acoustics:** The branch of acoustics that concerns the noise and vibrations produced by working mechanisms and their impacts on environment.

**Exocentric Judgment:** In auditory distance perception, a location in space perceived relative to another reference sound, i.e., as a location nearer or farther away than a previously experienced stimulus.

**Externalization:** The sensation that a sound source is located away from the head [see **Internalization**].

**Extrapolation:** The estimation of a value of a variable outside a known range of values by assuming that the estimated value follows logically from the known values.

**Far Sound Field:** A sound field at a certain distance from the sound source, at which the sound source can be treated as a uniform single source [see **Point Sound Source**]. The far sound field extends roughly beyond the distance of two wavelengths of a sound produced by the sound source [see **Near Sound Field**].

**Fightability:** The capability of being effective in a combat environment.

**Finite Impulse Response Filter:** A digital filter for which each output sample is a weighted sum of a finite set of input samples (non-recursive filter). The array of weights, known as coefficients or taps, has the same form as the impulse response of the filter.

**Flanging:** A special sound effect produced by mixing a signal with its delayed version.

**Focal Point:** A center of activity, attraction, or attention.

**Focus:** A point at which rays or geometric lines converge or from which they diverge or appear to diverge.

**Formant:** Of a complex sound, a range of frequencies in which there is an absolute or relative maximum in the sound spectrum (ANSI, 1994). A region of prominent energy in the acoustic spectrum of a sound.

**Fourier Analysis:** The mathematical derivation of a series of sinusoidal components from a complex waveform or pattern.

**Franssen Effect:** Phenomenon in which the faster initial transients of acoustic waves simultaneously arriving at a listener's ears determine the perceived location of the sound source. The Franssen Effect is caused by the [see] **interaural envelope difference**.

**Free Sound Field:** A sound field where the sound levels obey the [see] **inverse square law**. The free sound field is a part of the [see] **direct sound field** that extends to the region of the [see] **reverberant sound field**.

**Front-Back Confusion:** Misperception of the location of a sound source in the medial plane by 180 degrees. Front-back confusions may have either form of front-back or back-front errors.

**Granulation Distortion:** A distortion in a digital audio system attributable to the uncertainty in the level of the samples.

**Haas Effect:** Phenomenon in which the first acoustic information that arrives at a listener's ears determines the perceived location of a sound source. The Haas Effect is a form of binaural fusion [see **Binaural Fusion**], in which initial and delayed sounds are fused into a single sound having a spatial origin defined by the initial sound. When there are multiple reflections of a sound in a room, the auditory system uses the first signal for localization and suppresses the reflections that follow.

**HATS™ (Head And Torso Simulator):** A manikin with microphones in the ear canals at the eardrum position for making acoustic measurements and binaural sound recordings, developed by Brüel and Kjaer.

**Headgear:** A system that covers the head or a part of it.

**Headphones:** Earphones applied outside the ear and supported by a headband.

**Head-Related Transfer Function (HRTF):** A frequency domain representation of the changes in magnitude and phase of the auditory signal at the entrance of the ear canal relative to the signal at the source. The HRTF is believed to contain important information that leads to externalization of sound, localization of sound in the vertical direction, and localization of sound in monaural listening conditions. The HRTF represents a linear transformation that occurs as a sound generated by a point source propagates to the left and right ears of a listener. The HRTF includes diffraction effects by the head and torso, as well as the directional spectral shaping effects of the outer ear or pinna. Unless otherwise specified, the HRTF is assumed to be the free-field HRTF.

**Headroom:** The difference in level between the highest level present in a given signal and the maximum level of the signal the device can handle without noticeable distortion (White, 1987).

**Head Tracking:** Use of a sensing device mounted on the listener's head to monitor the movements of the head in horizontal and vertical directions.

**Hearing:** Sense by which sound is perceived. The process of perceiving sound.

**Hearing Protector:** A device designed or used to reduce the noise level reaching the auditory system (Department of Defense, 1999 - modified).

**Hearing Threshold:** [see Audibility Threshold].

**Helmet:** Device covering the head and used for protecting the user from hazard to the head. A modern helmet serves as both the head protector and the supporting element for the communication system.

**Hemi-Anechoic Room:** A room with a hard reflective floor whose other surfaces absorb all the incident sound energy over a frequency range of interest. A hemi-anechoic room simulates [see] free sound field conditions above a reflective plane such as the ground.

**Holographic Audio:** A method to re-create an acoustic field in a region around the listener's head via conventional coincident bi-directional microphones and loudspeaker reproduction.

**Home Theater Sound:** [see Surround Sound].

**HRTF:** [see Head-Related Transfer Function].

**Human Engineering:** The application of knowledge about human capabilities and limitations to system or equipment design and development to achieve

efficient, effective, and safe system performance at minimum cost and manpower, skill, and training demands (Department of Defense, 1999).

**Human Factors:** A body of scientific facts about human characteristics. The term covers all biomedical and psychosocial considerations including training and human performance evaluation (Department of Defense, 1999 - modified).

**Human Factors Engineering:** [see **Human Engineering**].

**Human Performance:** A measure of human functions and actions in a specified environment during the conditions in which the person will be operating.

**Icon:** A unique symbol or sign (as a word or graphic symbol) representing a phenomenon or a concept whose form suggests its meaning (Webster, 1999 - modified).

**Iconic Memory:** An analog of [see] **echoic memory** in the visual modality.

**Identification:** An act of absolute recognition. The process of uniquely labeling or naming an event or an object. The term "identification" applies to selecting one possibility from an infinite number of possibilities.

**Immersion:** The perception in a virtual environment of being a part of that environment.

**Infinite Impulse Response Filter:** A digital filter that has internal registers that contain past responses of the filter (recursive filter). Each output sample is a weighted sum of these registers added to the input sample. Thus, the filter has a theoretically infinite impulse response.

**Informational Masking:** A masking of one pattern with another pattern with similar information content.

**Insert Earphone:** Small earphone that is coupled to the ear canal proper by a tube, ear mold, or other device (ANSI, 1995).

**Intelligence:** The ability to adapt to new conditions and to successfully cope with life situations.

**Interaural Cross Correlation:** A measure of the difference in a signal received by the two ears (White, 1987). Its value varies from -1, meaning the signals are equal and out of phase, through 0, meaning the two signals have nothing in common, to +1, meaning the signals are equal and in phase.

**Interaural Envelope Difference:** The difference between the rise times (initial transients) of the sound reaching the right ear and the left ear of a listener.

**Interaural Intensity Difference (IID):** The difference between the intensity of the sound reaching the right ear and the left ear of a listener. IID depends on the location of the sound source and the frequency of the sound.

**Interaural Level Difference:** [see **Interaural Intensity Difference (IID)**]

**Interaural Phase Difference (IPD):** The difference in the phase of a sound reaching the right ear and the left ear of a listener. IPD depends on the location of the sound source and the frequency of the sound.

**Interaural Time Difference (ITD):** The difference in the time of arrival of a sound reaching the right ear and the left ear of a listener. ITD is independent of the sound frequency but depends on sound source location.

**Internalization:** The sensation that a sound source is located inside the listener's head. Sounds presented through earphones without spatial processing appear as internalized [see **Externalization**].

**Interpolation:** The estimation of a value of a function or series between two known values.

**In-the-Head Localization:** The sensation that all sound sources are located in the listener's head [see **Internalization**]. Stereophonic sounds are typically considered *lateralized* while spatial sounds are considered to be *localized*.

**Inverse Square Law:** A small omnidirectional sound source radiating energy into three-dimensional space, producing a sound intensity that decays in inverse proportion to the square of the distance from the sound source. A law of wave propagation that characterizes a [see] **free sound field**.

**Just Noticeable Difference:** [see **Difference Limen**].

**KEMAR™** (Knowles Electronic Manikin for Auditory Research): A manikin with two microphones at the eardrum positions, which simulates acoustic properties of an average adult head and torso (developed by Knowles, Inc.).

**Label:** A descriptive name or a set of symbols identifying an object.

**Labeling:** An act of designating or marking an object with a [see] **label**.

**Lateralization:** Determination by a listener of the apparent position of the sound source within the head, usually along the arc connecting both ears, during earphone listening [see **Internalization**].

**Law of the First Wavefront:** [see **Haas Effect**].

**Lesson Learned:** A proven experience of value in the conduct of future programs (Department of Defense, 1999).

**Lethality:** The capability of causing death.

**Lexicon:** A psycholinguistic term referring to a hypothetical store of words.

**Listening:** The process of attentive hearing.

**Listening Area:** A space intended for or occupied by listeners.

**Listening Room:** A specific space designated for critical listening and evaluation of sound.

**Localization:** The psychological process by which a listener determines the direction of an incoming sound. The process of localization applies to the sound sources perceived as being located outside the listener's head [see **Lateralization**].

**Logatom:** A meaningless sequence of phonemes connected together according to the rules of a given language. A meaningless syllable.

**Long-term Memory:** [see **Permanent Memory**].

**Loudness:** The auditory sensation by which sounds can be ordered along the continuum extending from quiet to loud.

**Loudspeaker Display:** An [see] **auditory display** using loudspeakers.

**Masked Hearing Threshold:** The sound pressure level (in decibels) at which a signal becomes distinguishable from other signals or noises (Department of Defense, 1999).

**Masking:** The process or the amount by which the threshold of hearing for one sound is raised by the presence of another sound.

**Masking Level Difference:** Any decrease (improvement) in the masked threshold obtained when two ears are used instead of one.

**Memorization:** A process of remembering (storing) information for future access [see **Memory**].

**Memory:** A hypothetical storage of information. The power or process of reproducing or recalling what has been learned and retained especially through associative mechanisms (Webster, 1999).

**Message:** A sequence of meanings carried by signals or communicated by speech.

**Microphone Technique:** A method of using microphones in order to achieve a specific goal.

**Minimum Audible Angle:** The smallest angular separation between two sound sources that a listener can detect.

**Minimum Audible Movement Angle:** The smallest distance of angular motion of a sound source that a listener requires in order to discriminate a stationary source from a moving source.

**Monaural:** Pertaining to, using, or involving the function of a single ear.

**Monaural Listening:** Listening with a single ear.

**Monaural Recording:** A recording made or a process of making the recording via a single channel of the [see] **binaural dummy head**.

**Monaural Signal:** An audio signal recorded with a single channel of the [see] **binaural dummy head**.

**Monophonic Recording:** A sound recording process that does not maintain information about spatial distribution of sound sources.

**Monophonic Signal:** Audio signal that does not contain information about spatial distribution of sound sources.

**Monophonic System:** A means to record, transmit, and deliver a [see] **monophonic signal**.

**Monotic Display:** An [see] **earphone display** presenting acoustic signals to a single ear of the listener.

**Monotic Mode:** A sound delivery mode in which auditory stimuli are delivered to a single ear of the listener.

**Most Comfortable Listening Level:** Sound pressure level of a given acoustic signal that is perceived by the listener as optimal in a particular environment.

**Most Comfortable Loudness:** [see **Most Comfortable Listening Level**].

**Near Sound Field:** A sound field in direct proximity of a source that cannot be treated as a uniform single source in which the resulting sound field has a complex nonmonotonic form. The near sound field extends roughly out to a distance of two wavelengths of the sound produced by the sound source [see **Far Sound Field**].

**Nonsense Syllable:** [see **Logatom**].

**Nyquist Frequency:** The theoretical minimum [see] **sampling frequency** required to reconstruct an analog signal [see **Sampling (Nyquist) Theorem**].

**Out-of-the-Head Localization:** The sensation that sound sources are located outside the listener's head [see **Externalization**].

**Oversampling:** 1. Sampling at a rate higher than that specified by the [see] **sampling (Nyquist) theorem**. 2. A technique where each sample from the data converter is sampled more than once, i.e., *oversampled*. This multiplication of samples permits digital filtering of the signal, thus reducing the need for sharp analog filters to control [see] **aliasing** (Rane, 1999).

**Panoramic Control:** A control system on audio mixers to move or *pan* the apparent position of a single sound source between two extreme locations, usually *left* and *right*, while maintaining equal sound power for all positions.

**Parameter:** A single property of a system whose measurable value determines the characteristics of the system.

**Pattern:** A natural or chance configuration of objects or data (Webster, 1999).

**Pattern Recognition:** A process of uncovering specific configurations of objects or data in solving problems of source recognition and identification.

**Percept:** An impression of an object obtained by use of the senses (Webster, 1999). A building block of overall perception.



**Perception:** A mental analysis of sensations based on prior experience and world knowledge to form a mental representation of the surrounding environment. Awareness of the surrounding environment through sensory stimulation. The conscious mental registration of a sensory stimulus.

**Performance:** The execution of an action or the manner of reacting to stimulation (Webster, 1999).

**Periphonic Sound:** [see **Spatial Sound**].

**Permanent Memory:** A hypothetical [see] **memory** of practically unlimited storage capacity where previous effects of stimulation and experience are stored.

**Phantom:** Something (as a specter) apparent to sense but with no substantial existence (Webster, 1999) [see **Apparent**].

**Phantom Sound Source:** [see **Virtual Sound Source**].

**Phasing:** A special sound effect produced by mixing a signal with its phase-shifted version.

**Phonic:** [see **Audio**].

**Pink Noise:** A wide-band signal for which the spectrum density changes as the inverse of frequency. Pink noise has equal energy per octave and can be created by passing [see] **white noise** through a filter that has a 3-dB/octave rate of decrease.

**Pinna:** [see **Auricle**].

**Pitch Height (or Pitch):** The auditory sensation by which sounds can be ordered along the continuum extending from low to high.

**Point Sound Source:** A hypothetical sound source that is very small compared to the wavelengths of the generated sounds and radiates into three-dimensional space (White, 1987 – modified).

**Polar Pattern:** [see **Directivity Pattern**].

**Precedence Effect:** [see **Haas Effect**].

**Preference:** An act of selection based on liking.

**Presence:** The perceptual illusion of realism in a virtual environment.

**Primary Display:** The [see] **display** that is most accessible to the user and usually the one most frequently used (Department of the Army, 1999).

**Process:** A natural phenomenon marked by gradual changes that lead toward a particular result or a series of actions or operations leading to a desirable end (Webster, 1999 - modified).

**Proximity Effect:** The increase in low frequency sensitivity of a microphone when the sound source is close to the microphone.

**Psychoacoustics:** The science that concerns the psychological correlates of the physical parameters of acoustic phenomena. Psychoacoustics is a branch of psychophysics concerning the relations between acoustic signals and observers' judgments of the signals.

**Psychology:** The scientific study of behavior and mental processes.

**Psychophysics:** The science that concerns the quantitative relationship between physical and psychological events.

**QSound™:** Proprietary [see] **spatial display** technology developed by QSound Company.

**Quadrature:** A situation when two identical signals are 90 degrees out of phase.

**Quantization:** The process of converting or digitizing an analog signal to a series of discrete levels.

**Quantization Distortion:** [see **Granulation Distortion**].

**Quantization Error:** The maximum difference between the value of an analog signal and the corresponding discrete level of the [see] **quantization** process.

**Recognition:** An awareness that something perceived has been perceived before (Houghton Mifflin, 1992). The process of realizing that an event or an object belongs to a given class. The term recognition refers to the act of assigning the object to a broad class of objects or selecting one possibility from a limited number of possibilities.

**Reconstruction Filter:** [see **Anti-Imaging Filter**].

**Resolution:** The smallest change in an input signal that causes a detectable change in the output signal. The smallest change in the stimulus that causes a specific reaction. The discrimination between two stimuli that differ only in one specific parameter.

**Reverberation:** Sound that exists in an enclosed space as a result of boundary reflections after the sound source ceases its operation.

**Reverberant Sound Field:** An acoustic field in which sound energy resulting from the boundary effects exceeds sound energy of the direct sound wave [see **Direct Sound Field**].

**RSX (Realistic Sound Experience) 3-D™:** An audio standard introduced by Intel that allows two speakers or a set of headphones to produce out-the-head positioning of audio samples. A set of high level libraries optimized to support [see] **Spatial Audio** in the [see] **VRML** worlds.

**Sampling:** The process of representing the value of an analog signal at a series of particular points in time (Rane, 1999 – modified).

**Sampling Frequency:** The frequency, usually expressed in kilohertz, at which an analog signal is converted to digital information. For example, an audio compact disk-read only memory uses a sampling frequency of 44.1 kHz.

**Sampling (Nyquist) Theorem:** A theorem stating that a band-limited continuous waveform may be represented by a series of discrete samples if the [see] **sampling frequency** is at least twice the highest frequency contained in the waveform.

**Saturation:** The condition where any further increase in input level will yield no further increase in output level.

**Selective Attention:** The human ability to concentrate attention on one of many activities happening simultaneously in the environment [see **Divided Attention**].

**Selective Listening:** The human ability to concentrate attention on one of many sound sources. Selective listening is a specific case of [see] **selective attention** within an auditory channel.

**Semantic Differential:** A rating of an idea, concept, or object on a series of scales (Eysenck et al., 1972).

**Sensation:** The primary experience of stimuli provided by sensory organs and the nervous system. The awareness of external or internal stimulation.

**Sensation Level:** The level by which the magnitude level of a specific stimulus exceeds the sensitivity threshold of an individual observer for that stimulus.

**Sensitivity:** The capacity of a system or sensory organ to respond to stimulation (Webster, 1999 – modified). The smallest value of the stimulus that causes a specific reaction.

**Short-term Memory:** [see **Working Memory**]

**Sigma-Delta Modulation:** [see **Delta-Sigma Modulation**].

**Signal:** The variable parameter that contains information and by which information is transmitted (Isaacs, 1996).

**Signal-to-Noise Ratio:** The ratio of some measured aspect of a signal to a similar measure of concurrent noise expressed usually in a logarithmic form. The measured aspect, frequency range, and statistical properties of the signal and the noise should be stated explicitly.

**Soldier System:** An individual soldier considered as a self-supporting fighting unit.

**Sonic:** [see **Acoustic**].

**Sonic Categorization:** A labeling process in which arbitrary sounds are used to identify members of specific categories of data or objects.

**Sonification:** (1) A mapping of numerically represented relations in a non-acoustic domain to relations in an acoustic domain to facilitate interpretation of the relations in the non-acoustic domain; (2) interpretation of data sets by representing the data with sound; and (3) data-controlled sound generation.

**Sonographic Audio:** A method for recreating an original sound field at a listener's ears by delivering conventional [see] **coincident-microphone recordings** through earphones.

**Sonorous:** Having or producing a full, deep, or rich sound (Rane, 1999).

**Sound:** The presence of a [see] **sound wave**. An auditory sensation caused by a sound wave.

**Sound Character:** auditory sensation enabling the listener to identify and differentiate sounds on the basis of their spectral and temporal properties. Sound character enables the listener to recognize sound sources and modes of their operations.

**Sound Effect:** A sound with a familiar association. A non-verbal sound event or a sequence of such events having natural meaning.

**Sound Event:** An acoustic event that is capable of being heard by a human listener and having a specific beginning and end.

**Sound Field:** [see Acoustic Field].

**Sound Locator:** An electroacoustic or electronic device used to locate a sound source.

**Sound Quality:** The overall satisfaction of a listener with a given sound.

**Sound System:** A technical means for delivering sound to listeners or to a specific area in space.

**Sound Wave:** An acoustic wave at a frequency that is capable of being heard by a human listener. The nominal frequency range of acoustic waves that can be heard extends from 20 Hz to 20,000 Hz.

**Space Perception:** The registration of sensory information about the spatial layout of the environment; that is, the distance and directions of objects from one another (Eysenck et al., 1972).

**Soundscape:** [see Acoustic Environment].

**Sound Transmission Loss:** The difference (in decibels) between sound pressure levels at the output and the input of any sound transmission [see] **channel**.

**Spaciousness:** An integrated auditory sensation caused by the spatial arrangement of sound sources and acoustic properties of the space surrounding a listener. Spaciousness enables a listener to perceive an apparent surrounding space and differentiate between various sound sources in the space.

**Spatial Audio:** [see] **Spatial Sound** created by electroacoustic (audio) means.

**Spatial Audiometry:** A measurement of auditory acuity as a function of the direction of the incoming sound.

**Spatial Audio Display:** [see Spatial Display].

**Spatial Display:** An [see] audio display in which icons appear to be located outside a listener's head at different spatial positions according to some underlying rules.

**Spatial Orientation:** The ability of a listener to determine where an object is located in space.

**Spatial Sound:** Sound creating a sensation that the sound sources are located outside the listener's head.

**Spatial Hearing:** A human listener's ability to localize sound sources and to identify acoustic properties of the surrounding space.

**Spatialization:** The process of modifying an audio signal for the purpose of making it appear to originate from a specific point in space.

**Spatializer™:** A single-ended spatial enhancement technique developed by Desper Products, Inc. The Spatializer™ technology manipulates the original stereophonic signal in a way that causes the listener to perceive a stereo image beyond the boundaries of two loudspeakers located at -90 and +90 degrees in front of the listener.

**S/PDIF (Sony/Philips Digital Interface):** A consumer version of the [see] AES/EBU bus. The official name for the standard is IEC-958, but it is marketed as S/PDIF for consumer applications.

**Spectrum:** A graphic representation of the signal in the frequency domain as a number of discrete frequency-related components (line spectrum) or as a continuous envelope (continuous spectrum). The spectrum represents changes of the signal magnitude (magnitude spectrum) or the signal phase (phase spectrum) as a function of frequency (continuous spectrum).

**Spectrum Density:** The limit of the ratio of signal energy to the signal bandwidth for the signal bandwidth approaching zero.

**Speech:** Oral communication (ANSI, 1995).

**Speech Intelligibility:** The percentage of speech units that can be correctly identified by a listener over a given communication system in a given acoustic environment. The degree to which speech can be understood during given conditions.

**Speech Unit:** A given construction block of speech such as phoneme, syllable, word, phrase, or sentence.

**Stereophonic Recording:** A sound-recording process that provides information about the spatial distribution of sound sources.

**Stereophonic Signal:** An audio signal that contains information about the spatial distribution of sound sources.

**Stereophonic System:** A means to record, transmit, and deliver a [see] stereophonic signal.

**Supernormal Auditory Localization:** The process of making listeners more sensitive to auditory location by exaggerating the normal interaural time, interaural intensity, and pinna cues.

**Supra-aural Earphone:** Earphone that rests on the external ear against the pinna.

**Surround Sound:** Sound created by a multi-channel speaker system intended to provide enhanced spatial information in the horizontal plane. The most common surround sound application is the 5.1 channel system that uses six channels. The designation "5.1" refers to five discrete full bandwidth channels (left, center, and right front channels and left and right rear channels) and to a limited band subwoofer (or special effects) channel. Surround sound formats include digital theater systems, Sony dynamic digital sound, and Dolby stereo digital.

**Survivability:** The capability of living or persisting in a hostile environment.

**Sustainability:** The capability of maintaining operations or conducting specific activities for a prolonged period of time.

**Sweet Spot:** The position between two or more loudspeakers where a listener must be positioned for a specific spatial perception to occur.

**Synthetic Listening:** The ability of a listener to perceive sound complexes or temporal sequences in a global fashion (McAdams & Bigand, 1993) [see **Analytic Listening**].

**Synthetic Sound:** An abstract electronic sound. A synthetic audio signal that does not simulate a natural sound.

**System Engineering:** A sequence of activities and decisions transforming an operational need into a set of system performance parameters and a preferred system configuration.

**Technical Listening:** Analytical listening to sound for the purpose of assessing its perceived character or sound quality (ANSI, 1995).

**Test Bed:** A standardized means for evaluating specific applications of new devices or procedures before their actual use.

**Three-Dimensional Audio Display:** [see **Spatial Display**].

**Three-Dimensional Sound:** [see **Spatial Sound**].

**Timbre:** [see **Sound Character**].

**Transaural Audio:** A method for re-creating an original sound field at the listener's ears by delivering a [see] **binaural recording** via loudspeakers. A transaural audio system equalizes an acoustic signal in such a way that its reproduction through a pair of loudspeakers results in recreating an original sound field at the ears of the listener.

**Transfer Function:** The output versus input response characteristics of a device expressed either mathematically or graphically.

**Transient:** An abrupt change of state. A sudden change in signal magnitude.

**Treble:** The upper region of the audio frequency range, from about 5,000 Hz.

**TruSurround™:** A proprietary technology developed by Sound Retrieval System (SRS) Labs that creates a [see] **surround sound** experience from a two-loudspeaker playback system that plays any multichannel audio signal.

**Ventriloquism Effect:** The ability of a visual stimulus to alter the actual location of a sound source to correspond to the location of the visual object.

**Verbal Message:** A message consisting of words

**Video:** Pertaining to a light signal encoded in electrical form and to the means of its transmission.

**Video Display:** A [see] **visual display** generated by video signals.



**Video Icon:** A visual icon generated by a video signal.

**Video Signal:** A visible light signal in electrical form. A stream of electrical information to be seen by an observer or displayed by a video display.

**Virtual:** [see **Phantom**].

**Virtual Acoustic Display:** An [see] **acoustic display** in which acoustic signals evoke auditory images that appear to originate from points in space that are different from the actual sources of sound.

**Virtual Acoustic Reality:** [see **Virtual Sound Space**].

**Virtual Acoustics:** A simulation of the complex acoustic field experienced by a listener within an environment.

**Virtual Auditory Display:** [see **Virtual Acoustic Display**].

**Virtual Reality:** The use of computer technology to create the effect of an interactive three-dimensional world in which the objects have a sense of spatial presence [Omnibus Library, 2001].

**Virtual Sound Source:** An apparent sound source. A perceived position of the sound source at a point different from the point of sound emission.

**Virtual Sound Space:** An apparent acoustic environment surrounding a listener.

**Visual:** Pertaining to the sense of sight.

**Visual Capture:** [see **Ventriloquism Effect**].

**Visual Display:** A display presenting information capable of being seen.

**Visual Icon:** An icon intended to be seen.

**Visual Signal:** A signal received or intended to be received by the eye.

**Warning Signal:** A signal that alerts the operator to a dangerous condition requiring immediate action (Department of Defense, 1999).

**VRML:** Virtual Reality Markup Language. A computer scripting language for describing three-dimensional objects and worlds.

**Waveform:** A graphic representation of a signal (wave) in the time domain or along its path of propagation.

**Wavefront:** A continuous surface of a progressive wave in space that is a locus of points having the same phase at a given instant.

**White Noise:** A wide-band signal for which the spectrum density is independent of frequency.

**Weighting Filter:** A special equalizer that provides different attenuation at certain frequency bands in order to correlate an output signal with a perceptual assessment of sound or another stated criterion such as an average spectrum of long-term speech. Common weighting filters include A-, B-, C-, D-, and E-weighting filters.

**Working Memory:** A hypothetical [see] **memory** of relatively short duration (2 to 10 s) and limited capacity within which incoming information is assessed and processed (coded) while being transferred to [see] **permanent memory**.

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13. ABSTRACT (Maximum 200 words)  This report is a lexicon of terms developed by the Department of Defense Spatial Audio Display Working Group in an attempt to standardize terminology used by human factors researchers working in the area of auditory displays and human-machine communication. The lexicon has been primarily developed for the U.S. armed forces research groups, but it is hoped that it will be also useful for other Government, academic, and industrial organizations. In addition to definitions specific to auditory displays, speech communication, and audio technology, the lexicon includes several terms unique to military operational environments and human factors engineering applications. Furthermore, human factors researchers appear to be increasingly interested in conducting integrated studies of auditory and visual perception in order to answer broad questions related to human situational awareness and performance. Therefore, the lexicon also includes some definitions related to visual perception, particularly in the areas of visual displays, virtual reality, and communication symbology.					
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